

His observations are in accordance generally with those communicated by Mr. Lockyer to the Royal Society.

The author describes the examination of a spot on April 15th, 1868. He shows that about three-fourths of the apparent light of the umbra came from that region of the sun, and the remaining fourth from the intervening illuminated atmosphere of the earth. He observed an increase of width in most of the dark lines of the solar spectrum. The lines C and F, due to hydrogen, did not appear stronger in the spectrum of the umbra. No new lines were detected, nor were any of those of the normal solar spectrum observed to be wanting in the spectrum of the light from the umbra. No bright lines were seen.

Some of the conditions of the solar surface are considered which the phenomena observed may be supposed to indicate.

A cooler state of the heated vapours by which the lines of absorption are produced would diminish the radiation from the gas itself, and so leave more completely uncompensated the absorption by the gas of the light from behind it. Though in this way an apparent increased intensity of the dark lines would result, the observations seem to suggest a state of the vapours connected with tension and temperature in which their power of absorption for each line embraces an increased range of wavelength. Some of the conditions under which this state of things may be brought about are discussed.

The absence of bright lines is not considered as conclusive of the complete absence of light in the umbra from luminous gas; for if there existed in the spot or above it the same vapours in a cooler state, the light would be almost wholly absorbed, and the feebler emanations of the cooler vapour might not do more than render less intense the dark gaps produced by the vapours in the stronger light of all refrangibilities which is evidently present.

What is the source of the light in the umbra which gives the continuous spectrum? May the dense and intensely heated gases, which probably form the inner substance of the sun, emit, in some cases, lines so greatly expanded as to form, when numerous spectra are superposed, a sensibly continuous spectrum? Dr. Balfour Stewart has suggested that, as gases possess a power of *general* absorption of light, a heated mass of gas, if sufficiently dense to be opaque or nearly so, would give a continuous spectrum as well as the spectrum of bright lines peculiar to it.

VIII. "On the Spectrum of Brorsen's Comet, 1868." By WILLIAM HUGGINS, F.R.S. Received May 14, 1868.

In January 1866 I communicated to the Royal Society the result of an examination of a small comet visible in the beginning of that year*. I

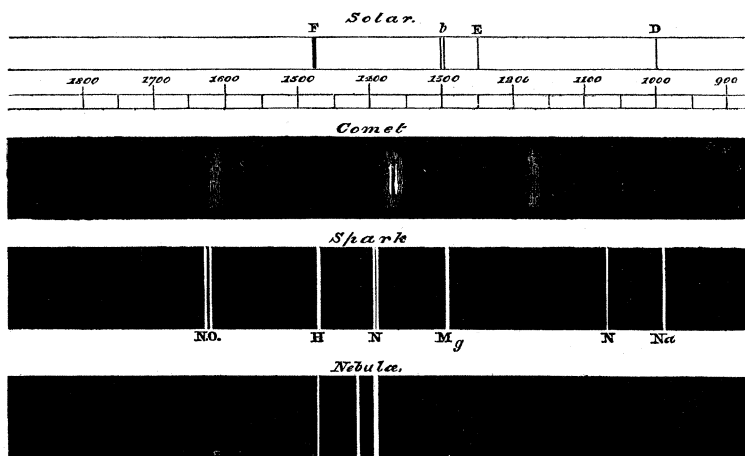
* Proceedings of the Royal Society, vol. xv. p. 5.

examined the spectrum of another small and faint comet in May 1867. The spectra of these objects, as far as their very feeble light permitted them to be observed, appeared to be very similar. In the case of each of these comets, the spectrum of the minute nucleus appeared to consist of a bright line between B and F, about the position of the double line of the spectrum of nitrogen, while the nebulosity surrounding the nucleus and forming the coma gave a spectrum which was apparently continuous.

Unfavourable weather prevented me from obtaining an observation of Brorsen's comet, at its present reappearance, before April 29. Since that evening I have examined it on May 2, 4, 6, 7, 12, 13. As I have not noticed any change in its spectrum during this time, I will put together the results of my observations on different nights, in order to avoid the repetition which would occur if the observations were arranged in the order in which they were made.

I tried various spectroscopes upon this object. The best views of its spectrum were obtained with a spectroscope of the form already described in my former papers*, and furnished with one prism of very dispersive flint glass, with a refracting angle of 60° . Some measures were taken with a similar spectroscope, with two prisms of 60° .

The comet appears in the telescope as a nearly round nebulosity, in which the light increases rapidly towards the centre, where on some occasions I detected, I believe, a small stellar nucleus. Generally this minute nucleus was not to be distinguished from the bright central part of the comet.



I suspected two or three bright points in the coma. May 7, I perceived a small extension of the faint surrounding nebulosity in a direction opposite to the sun, so as to form a short tail.

The spectrum of this comet consists for the most part of three bright

* Philosophical Transactions, 1864, p. 415.

bands. The length of the bands in the instrument shows that they are not due alone to the stellar nucleus, but are produced by the light of the brighter portions of the coma.

I took some pains to learn the precise character of these luminous bands. When the slit was wide they resembled the expanded lines seen in some gases; for example, the line F in the spectrum of hydrogen at the atmospheric pressure. As the slit was made narrow the two fainter bands, namely the one in the yellow and the one in the blue, appeared to fade out without becoming more defined. I was unable to resolve these bands into lines. In this respect they are very different from the bright lines of the nebulae, which become narrow as the slit is made narrow.

The middle band, which is so much brighter than the others that it may be considered to represent probably three-fourths, or nearly so, of the whole of the light which we receive from the comet, appears to possess similar characters. In this nebulous band, however, I detected occasionally two bright lines, which appeared to be shorter than the band, and may be due to the nucleus itself. This suspicion seems to be strengthened by the circumstance that when by moving the telescope the image of the comet was made to pass before the slit, these brighter lines were only observed when the middle of the comet was upon the slit, while the nebulous band continued as long as any part of the comet, except its extreme margin, was upon the slit.

Besides these three bright bands there was a very faint continuous spectrum. This spectrum is omitted in the diagram, as it could scarcely be represented without making it appear too strong relatively to the bright bands.

The position in the spectrum of the bands was determined by micro-metrical measures, and also by simultaneous comparison, of the bands with the bright lines of magnesium, sodium, hydrogen, and nitrogen. The brightest band, which is in the green part of the spectrum, is nearly in the position of the brightest line of the nebulae, which coincides with the double line of the spectrum of nitrogen; but, as the diagram shows, the band in the comet is in a small degree less refrangible than the line of nitrogen. This difference of refrangibility cannot be attributed to the comet's motion, since at the time the observations were made the comet was approaching the earth.

The band in the blue is considerably more refrangible than F, and is nearly as refrangible as the group of bright lines in the air-spectrum, which have the numbers 2642, 2669 in the map and tables of my paper "*On the Spectra of the Chemical Elements*"*.

The least refrangible of the bands occurs in the yellow part of the spectrum, at about the distance from E of one-third of the interval which separates E from D.

The spectrum of this comet resembles the diagram given by Donati of

* *Astronomische Nachrichten*, No. 1488.

the spectrum of Comet I., 1864*. The positions of the three bands seen by him appear to agree with those which the bright bands of this comet occupy.

This comet differs remarkably from the two small comets which I examined in the much smaller relative proportion of the light which forms a continuous spectrum. In Brorsen's comet, as it now appears, the bright middle part of the nebulosity seems to have a constitution analogous at least to that of the nucleus, and to be self-luminous; in the other comets the coma, which surrounded a distinctly marked nucleus, gave a continuous spectrum. The three comets resemble each other in the circumstance that the light of the bright central part was emitted by the cometary matter, while the surrounding nebulosity reflected solar light.

The telescopic observations of the heads of Donati's comet and of other large comets have shown that the luminous material is not at once driven off into the outer portions of the coma and the tail, but usually forms in front of the nucleus a dense luminous cloud, which for a time seems to be identical in the character of its light with that of the nucleus. It is, I believe, the outer portions only of the coma, which are frequently separated by dark spaces from the nucleus, and the tail, which the polariscope has shown to shine by reflected light.

The positions of the bands in this comet would seem to indicate a chemical constitution different from that of the nebulae, which give a spectrum of bright lines. It will be seen in the diagram that, though the brightest of the bands in the spectrum of the comet differs but little in position from the brightest line of the nebulae, the other bands are found in parts of the spectrum widely removed from those in which the other lines of the nebulae occur. The suggestion presents itself whether the broad, nebulous bands may not indicate conditions of temperature and molecular state different from those which occur in the gaseous nebulae. Plücker has shown that nitrogen and some other substances give totally different spectra, under different conditions of temperature and tension. The spectrum of this comet, however, does not resemble the other spectrum of nitrogen, which Plücker distinguishes as the spectrum of the first order†.

IX. "Mémorial on 'Undevelopable Uniquadric Homographies.'" By MARTIN GARDINER, C.E. Communicated by the Rev. R. TOWNSEND, F.R.S. Received April 13, 1868.

(Abstract.)

In this paper the author's method of investigation is purely geometrical throughout, its arrangement of details is systematic and natural, and it is divided into eight chapters, the first seven of which are preparatory to the consideration of the interesting problem discussed at length in the eighth,

* Philosophical Transactions, 1864, p. 158.

† Ibid. 1865, p. 9.

